

SIMULATION AND STIMULATION

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SUMMARY

This is a talk to be delivered before the Second National Symposium on Simulation Processes, Chicago, Illinois, on February 3, 1959.

It is devoted to an analysis of the qualities required for the successful construction of mathematical models of economic, psychological, and military processes, and to a discussion of why the universities have almost completely failed in the job of turning out people possessing these qualities.

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The function of the keynote speaker is to ~~indulge~~ proceedings on a high level. In so doing, it is not absolutely necessary that anything of substance be said, and this policy possesses the additional merit of not stealing any of the lines of the following speakers.

Pursuant to this tradition, I would like to state that I am against sin and high taxes, and for motherhood--although, perhaps not precisely in this order.

Nevertheless, in violation of the existing gentleman's agreement, I would like to discuss some matters of substance. In so doing, I shall make some controversial statements, and in the course of this pleasant occupation, make some unpleasant remarks. Naturally, I would prefer to make only the most laudatory remarks, but occasionally there is not sufficient opportunity to indulge in this pastime.

What motivates much of what follows is the fairly generally accepted statement that not only does life influence art, but perhaps even more strongly in some areas, art influences life.

My application of this dinner table philosophy was, I thought, new. As a result of a fortunately brief Army career, I came to the conclusion that the behavior of Army sergeants was to a large part inspired by the movies they had seen.

Sergeant Flagg of "What Price Glory," as personified by Victor
McGill, made an indelible impression upon American youth.

I cherished this theory, and expressed it often. As a theory it was heady and exhilarating, far more fascinating than any prosaic fact. A bland enunciation of a deadly object such as a fact--"The moon is 240,000 miles away"--is digested and accepted. This process generally casts a pall over the conversation. But a theory, particularly an undocumented or undocumentable one, stimulates attack and rebuttal--life becomes interesting.

Imagine then my consternation to find that my theory had a factual basis! The discovery, like most discoveries, came about quite by accident. In connection with an OR conference, I found myself sitting next to a movie mogul, a vice-president of one of the major studios. After listening patiently to a half-hour recital of the parking and traffic difficulties of Beverly Hills, I broke in to expound my theory. I expected debate, defense, at least disbelief. Instead of which, this Colossus of Hays Codes nodded his head in complete agreement, and proceeded to inform me that the War Department, early in World War II, had sent letters to all the major studios asking them to change the characterization of an Army sergeant from that of a dyspeptic overseer on an antebellum plantation to that of a Scoutmaster.

So much for a cherished theory. I have never expounded the theory since--it is too well documented!

The connection of all of this with the study of simulation processes is not too difficult to make. What I am saying is that the type of model of the physical world that is constructed is determined by the scientific training and philosophy of the model-maker. This, in turn, influences to a great extent the type of answer that the model yields, and, to a far greater extent, the interpretation of these answers.

We know by now that there are no critical experiments, only critical experimenters. The history of science is replete with examples of complete disregard of data and results unfavorable to pet theories.

It follows that if we are interested in furthering the art of simulation, if we are desirous of using this supple and versatile tool to analyze and resolve the fascinating and significant problems of the world around us, then we must very critically examine the people who will use these techniques.

As people, they are products of the entire society; as professional people, they are products of our colleges and universities. It follows that if we wish to understand the psychologies and philosophies, and ultimately the theories and results, of these researchers, we must examine their intellectual training.

Before doing this, and in order to set up an appropriate yardstick, let us say a few words about why research must be conducted in the field of simulation, and about the qualities that are needed to conduct this research.

Let us begin with the concept of a mathematical model in the physical sciences. It is well to do this since for many a year the very model of modern research has been the mathematical physicist. His success in a wide area has so bedazzled the workers in other fields that it is now widely accepted that the road to scientific respectability in these fields is of necessity paved with mathematical equations. The more tables, the more charts, the more statistics*, the greater the aura of shimmering TRUTH.

Whereas it was once said that man is the measure of all things, in the social sciences it is now commonly held that all things are to be used to measure man.

The method that the physical scientist uses is a simple one. This is not to say that it is a natural one, or a logical one. It was not so long ago that it was considered impious to confront a theory with a fact, and there are still parts of the world, some not as remote as we would like to believe, where inconvenient facts are summarily rejected.

To study a phenomenon, we set up certain simple hypotheses concerning fundamental effects. These simple hypotheses are translated into mathematical equations, usually considerably less simple. Thus, one set of experimental data leads to Maxwell's equations, another bold extrapolation produces the Schrödinger equation.

* Mark Twain once said that there were three kinds of lies: lies, damn lies, and statistics.

The solutions of these equations yield certain predictions concerning the behavior of various physical systems. When these predictions are compared with actual behavior, the trouble starts.

Naturally, predicted behavior will never agree exactly with observed behavior. It is up to us to decide whether these discrepancies are "experimental errors"--a most useful phrase--or ~~due to~~ inadequacies of our initial assumptions. These are matters of extreme delicacy and in many significant instances settled on purely emotional grounds.

If we feel that the errors are bearable, we use the theory for further predictions until it breaks down completely. At this point we construct a new mathematical model.

Unfortunately, there are many important areas in which this elegant and effective method is stymied. Sometimes, we cannot make reasonable hypotheses concerning cause and effect; sometimes, crucial data is unobtainable, or crucial experiments non-existent.

This is particularly the case in the social sciences where human beings play a dominant role. Despite some of the best and determined efforts of professional educators and professional agitators, the human organism continues to escape the narrow constraints of rigid behavior.

This pernicketiness of the human soul is viewed with a certain amount of sorrow in some quarters. It invalidates elegant utility functions, nonlinearizes equations, introduces

stochastic effects, and generally does to shiny mathematical models what a small boy does to a new pair of shoes.

Since, however, it is essential that we understand the behavior of systems with human components, we must employ different techniques. It is in this way that simulation processes occupy a fundamental role in the social sciences.

To explain this in any detail would take up too much time, invade the domains of subsequent speakers, and, in any case, prevent one from uttering the unpleasant controversial remarks which follow. As I stated before, I greatly regret having to utter these sentiments.

I have gone as far as I have in this scanty discussion of the well-known formidable difficulties in the way of scientific study of industrial, economic, military and sociological problems in order to pave the way for an enumeration of some of the basic requirements for research in the area of simulation. These are:

1. An understanding of the nature and objectives of models of the physical world, which is to say, a knowledge of scientific philosophy.
2. An understanding of the nature and objectives of models of the areas named above, which is to say, a knowledge of philosophy.
3. A versatility and breadth of training which enables one to cut across diverse fields and construct useful models of realistic processes.

4. An ability to analyze and interpret the results obtained from these models against a still broader background.

If you, the listener, interrupt to say that this sounds like a "powerful lot" of requirement, I will retort that no one ever said that these problems were simple, or that they had simple answers.

Agreeing that a great deal is required, let us ask where people possessing these qualities are to be found, and before being found, to be trained.

It is clear that the university is the natural breeding ground for these paragons. Let us now examine why it is that they have failed dismally to produce professional ~~people with~~ the proper training, and why the situation will get worse before it gets better.

I hope that I do not document this thesis too well, since I would certainly prefer to be wrong rather than to be right. Furthermore, it is a fine controversial theory, both in and out of academic circles, and it would be a shame to destroy it as a topic of conversation.

Let us turn to the subject of scientific philosophy, a domain I will rather arbitrarily delimit as the study of the construction, analysis and interpretation of qualitative and quantitative models of the physical world. Vague as these terms are, they provide a sufficient, intuitive basis for our subsequent discussion.

What is regrettably lacking in the scientific training of our universities is a proper spirit of humility. The impression is somehow transmitted that we possess the keys to the universe. It is interesting to see how far one has to travel before it is realized that Ohm's law is an approximate result valid only in the case of not too high frequency, that Newton's laws of motion are not laws, and that the Schrödinger equation is not an axiom of nature. Even to this very day, despite all the evident absurdity of the scientific dogmatism in the past, there are still some who maintain the eternal verity of the Uncertainty Principle.

One result of this rather pathetic obduracy is that the average graduate student in the sciences is led to believe that the mathematical models already in existence are true, whereas models in new areas of physics are only approximate. Concerning models in the social sciences, he has only contempt*.

This rigidity of outlook is hardly conducive to effective analysis and research in new areas. Einstein in his brief autobiographical sketch comments bitterly that the school instruction he received almost ruined him.

Only by a continued study of the history of science can we understand the development of new ideas. Only by appreci-

* See the interesting paper by Helmer and Rescher, The Epistemology of the Inexact Sciences, The RAND Corporation, Paper P-1513, 1958, for a further discussion of this point.

ating the struggle of what is by now classic to emerge into the light can the student understand what research requires. The presentation of mathematical and physical theories emerging full-grown like falling atoms from the sky of ideas is misleading and dishonest.

This, however, is the usual way the sciences are presented in our schools. Mathematics, of course, suffers even more horribly from this type of pedagogy. There is even a strange group called the Bourbaki/ who boast of eliminating all motivation, all contact with the real world⁵!

No theory can exist without facts. There are, however, so many facts, so many clues, that without the help of logical tricks for selecting and storing facts, a scientist becomes little better than a technician. This collection of logical tricks is the substance of scientific philosophy.

Consider now the domain of the social sciences. One of the most pernicious fables muddying the academic domain is that of a hierarchy of intellectuals. The mathematicians, in this fictitious ranking, are at the summit, followed closely by the theoretical physicists, next the experimental physicists, then the chemists, and then the engineers. On the fringe of science, there are the biologist, and below are the ascertained social scientists. This is a pleasing fancy--to most mathematicians--and what is rather sad is that the social

⁵Incidentally, the focal point of this infection is not too far from where I speak.

scientists by and large believe this nonsense. Hence, their attempt to dress their subjects with as much mathematics as possible.

There are many frightening aspects to this snobbery. In the first place, it has the effect of turning out a number of robot mathematicians, robot physicists, and robot engineers who have no interest in human values. In a world in conflict over human values, to have these automata spewed out by the universities year after year is a serious matter.

What is even worse is that these "scientists" have the impression that the problems of the social scientists are on a lower level than those of quantum electrodynamics, and hence easier. Now nothing could be more mischievously false. The ~~more quantitative~~ subject the easier, regardless of superficial mathematical complexities; the more qualitative, the more human, the more difficult.

It is hard to imagine how one can commit a more grievous mistake than to enter a more difficult area with the fixed impression that it is a simpler area.

These misconceptions could be corrected in part or in whole by some emphasis upon history, economics, psychology, or what are commonly called the life sciences. Primarily, what is required is a basic knowledge of philosophy. By this I do not mean the twaddle that masquerades under this honorable name, the pap that is poured down our throats in college that would certainly repel any honest man. Nor do I

mean the ancestor worship that allows Plato still to occupy an honored position. Rather I mean a grounding in the basic objectives of a cultured and civilized^{*} human being, these beacons which enable us to chart our courses over the troubled seas of modern existence.

Although answers to many of the basic questions are incomplete, a very awareness of the existence and significance of these problems is a good step towards their solution.

The scientist untutored in these matters, biased and arrogant, is hardly the person to construct models of the complex processes of social interaction. On the other hand, the social scientist trained in the pseudo-science that drips over the edges of these domains, is hardly competent. We desperately need a blending of the best of all intellectual disciplines, an eclectic training that will enable us to approach these problems that are unaware of artificial barriers.

Yet the narrow parochialism of the modern university--oh, ironic title!--hardly allows this. The emphasis upon facts rather than ideas, upon subjects rather than problems, effectively rules out the "systems" approach so essential in the study of any significant situation.

It is easy to continue tearing into the present university system. But there is no point in doing so unless some

^{*}Contemporary history teaches us that there need be no correlation between these qualities.

constructive criticism is also made.

Why is there so much decadence and dry rot in the university system? Could it be because the university is staffed by and large by people who hate and reject life? Could it be that many vital people who rely on the master of the outside world are in turn repelled by the monasticism and forced asceticism of the university? I think that this explains much of it.

The fallacy of having the young idealists of a dynamic society trained by those who repudiate these very dynamic aspects hardly needs elaborating. This situation perpetuates itself in the form of students aping the master. The result is a continued and growing cleavage with rejection and resentment increasing on both sides.

The cure is not difficult. It lies in blood transfusions in both directions. The doers of our society, the politician, the businessman, the industrial scientist, the engineer, must participate in undergraduate and graduate education. They must explain their problems and their goals, their operational techniques and their solutions--in short, their philosophy.

Reciprocally, the university faculty must be forced willy-nilly into the glare of sunlight to participate in the problems of their society. It is here that the ~~state~~ corporations and government bureaus and laboratories can play a vital role.

We are engaged in a battle of survival, our way of life

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against other ways of life, in which the most potent bullets
are ballots. Unless we make quite sure that our own side
understands clearly and vividly what our fundamental objectives
are, how can we convince any other side?